AbstractID: 1798 Title: 3D analytical dosimetric model for radiation treatment planning with the HDR Leipzig surface applicator

The dose-rate distributions from a Nucletron HDR Leipzig surface applicator were calculated using Monte Carlo simulations. The MC simulations were verified by phantom measurements. The dose-rate distributions from this applicator were significantly different from that produced by a bare source. Therefore, a 3D analytical dosimetric model was developed for treatment planning with this applicator. Calculated dose-rate distributions were modeled as $\dot{D}(r,\theta,\varphi) = \Lambda_{ref} \times S_K \times (r_0/r)^2 \times \bar{g}(r) \times \bar{F}(r,\theta,\varphi)$ where radial distance r, polar angle θ and azimuthal angle φ are defined with respect to the applicator's central axis instead of the source itself. Λ_{ref} is the dose-rate constant at the reference point (r_0=22mm, $\theta=0^0$). S_K is the source strength. The radial dose function $\bar{g}(r)$ is fitted by a polynomial. The profiles of applicator's anisotropy function $\bar{F}(r,\theta,\varphi)$ at $\varphi = 0^0$ and 90^0 are fitted separately at each radial distance by the formula $\delta(r) + A(r) \times E_{erfc}(\frac{\theta-\theta_0}{\sigma(r)}) + B(r) \times \begin{cases} e^{-\sigma_\alpha(r)\times(\theta-\theta_0)} & \text{for } \theta \geq \theta_0 \\ 2\text{-}e^{-\sigma_\beta(r)\times(\theta_0-\theta)} & \text{for } \theta < \theta_0 \end{cases}$. The complementary error function E_{erfc} describes the collimated dose edge, the exponential terms describe the inner and outer scattered doses, and δ(r) is the background doses. The obtained amplitude (A and B) and slope (σ and $\sigma_{\alpha,\beta}$) parameters at various radial distances are fitted by linear functions of radial distance. In 2-20mm depths, the differences between the analytical model and MC simulation are within 3% and 5% inside and within 20 mm outside collimating edge respectively and 0.3 mm near the collimating edge. The analytical model provides an accurate and efficient method for the 3D treatment planning of Leipzig applicator.